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STEAM INJECTION SYSTEM ON THE TLE CONES OF A HYDROCARBON CRACKING FURNACE

This invention relates to a method to reduce formation of a coke material on a Transfer Line Exchanger (TLE exchanger) tubesheet by injecting steam in a hydrocarbon effluent from a hydrocarbon cracking furnace. This invention particularly relates to an apparatus for injecting steam into a hydrocarbon effluent from a hydrocarbon cracking furnace to reduce the coke material from forming on a TLE exchanger tubesheet at the outlet of the hydrocarbon cracking furnace.

Background of the Invention

Ethylene is produced by cracking a hydrocarbon feed to produce a hydrocarbon effluent comprising ethylene and numerous other products such as, for example, propylene, butadiene, and benzene. The hydrocarbon cracking is conducted at extreme temperatures, and the hydrocarbon effluent produced then flows from the hydrocarbon cracking heater to the TLE to be cooled. In addition to producing ethylene and other products, a coke material is also produced. The coke material can adhere to a TLE exchanger tubesheet, and eventually will require that the hydrocarbon cracking furnace be shut down in order to mechanically clean the TLE exchanger tubesheet. The adhesion of the coke material is partially because the hydrocarbon effluent velocity is lower on the outer edges of the TLE cone than in the center. Therefore, the reduction in velocity can cause the hydrocarbon effluent to swirl or form eddies, thereby causing the hydrocarbon effluent to have a higher resonance time. Generally, when the TLE exchanger is removed for cleaning, up to 20% of the TLE exchanger tubesheet is covered with coke material thus restricting heat transfer and thereby reducing the efficiency of the hydrocarbon cracking furnace.

An inventive solution has been discovered to substantially reduce the coke material from forming on the TLE tubesheet.

Summary of the Invention

It is an object of this invention to provide a method for reducing formation of a coke material on a TLE exchanger tubesheet of a hydrocarbon cracking furnace.

It is another object of this invention to provide an apparatus for injecting steam to reduce the formation of coke material on a TLE exchanger tubesheet of a hydrocarbon cracking furnace.

In accordance with this invention, an apparatus to inject steam into a hydrocarbon effluent passing through the TLE cone of a hydrocarbon cracking furnace is provided. The apparatus comprises:

(a) at least one injection probe, which is connected at an angle in a range of about 30 to about 60 degrees to the TLE cone; and

(b) a distribution nozzle, which is connected to the end of said injection probe, wherein the injection probe and distribution nozzle protrude into the TLE cone by a distance in the range of about 1% to about 10% of the radius of the TLE cone.

In further accordance with this invention, a method to inject steam into a TLE cone of a hydrocarbon cracking furnace to reduce formation of a coke material on the TLE exchanger tubesheet is also provided. The method comprises:

(a) injecting steam through at least one injection probe wherein the injecting is accomplished by the apparatus described previously.

Brief Description on the Drawings

FIG 1. An overall view of the flow from a hydrocarbon cracking furnace to a TLE exchanger is provided.

FIG 2. A side view of a TLE cone is provided.

FIG 3. A detailed depiction of one embodiment of the apparatus illustrating the injection probe position within the wall of the TLE cone and the distribution nozzle used to inject the steam into the hydrocarbon effluent.

FIG 4. A detailed depiction of the preferred mode of operation of the apparatus involving six injection probes that are 60 degrees apart around the circumference of the TLE cone.

Detailed Description of the Invention

To reduce the formation of a coke material on a TLE tubesheet **6**, an apparatus to inject steam into a hydrocarbon effluent **48** passing through a TLE cone **42** of a hydrocarbon cracking furnace **44** is provided, the apparatus comprising:

(a) at least one injection probe **35**, which is connected at an angle **38** in a range of about 30 to about 60 degrees to the TLE cone **42**; and

(b) a distribution nozzle **32**, which is connected to the end **34** of the injection probe **35**, wherein the injection probe **35** and distribution nozzle **32** protrude into the TLE cone **42** by a distance of in the range of about 1% to about 10% of the radius of the TLE cone **15**.

The production of ethylene is accomplished by subjecting a hydrocarbon feed **46** to severe temperature in a hydrocarbon cracking furnace **44.** The temperature ranges from

about 1500°F to about 1700°F. A hydrocarbon effluent **48** exits the hydrocarbon cracking furnace **44** at this severe temperature, and it then is quenched to a temperature below 1000 F through the use of a TLE exchanger **43.** A coke material can be formed in the TLE cone **42** when the hydrocarbon effluent **48** is entering the TLE exchanger **43**. The coke material also can form on the TLE exchanger tubesheet **6**. This formation of coke material can eventually plug the TLE exchanger **43** requiring the hydrocarbon cracking furnace 44 to shut down for maintenance.

The coke material is formed more rapidly in low flow areas **7 and 9**. Low flow areas **7** and **9** are found on the outer edge of the TLE cone **42.** The higher flow area is in the center of the TLE cone **14** and the center of the hydrocarbon effluent **10.** Injecting steam into the low flow areas **7** and **9** can decrease the resonance time that the hydrocarbon effluent takes to flow through the TLE cone **42**. The steam injection also quenches the hydrocarbon effluent. The result is less coke material formed on the TLE tubesheet **6**.

The apparatus comprises at least one injection probe **35** and at least one distribution nozzle **32**. The injection probe **35** is connected to the TLE cone **42** making an angle **32** in a range of about 30 degrees to about 60 degrees as it protrudes through the refractory lining of the TLE cone **11.** Preferably, the angle **32** is 45 degrees. Preferably, the injection probe **35** is located at a distance **16** from the TLE tubesheet **6** in a range of about 12 inches to about 36 inches, most preferably, 12 inches to 24 inches. A distribution nozzle **32** is connected to the end of the injection probe **34** to distribute the steam flow. The injection probe **35** and distribution nozzle **32** protrude into the TLE cone **42** by about 1% to about 10% of the radius of the TLE cone **15**. Preferably, the injection probe **35** and distribution nozzle **32** protrude about 1% to about 3% of the radius of the TLE cone **42**. In addition,

the location of the injection probe **35** and distribution nozzle **32** can prevent erosion of the distribution nozzle **32** due to the low velocity of the hydrocarbon effluent. The hydrocarbon effluent **48** flow rate is increased by injecting steam in the low velocity areas **7** and **9** of the TLE cone 42 downstream of the injection probe **35**, which ultimately reduces the formation of the coke material on the TLE exchanger tubesheet **6**. The distribution nozzle **32** injects steam in the direction of the hydrocarbon effluent **48** flow. Preferably, there are six injection probes **20, 22, 24, 26, 28** and **30** at an angle of about 60 degrees apart around the circumference of the TLE cone **42**.

A method to inject steam in a hydrocarbon effluent passing through the TLE cone of a hydrocarbon cracking furnace **44** to reduce formation of a coke material on the TLE exchanger tubesheet **6** is provided. The method comprises:

(a) injecting steam through at least one injection probe wherein said injecting is accomplished by the apparatus described previously.

A sufficient amount of steam must be injected to reduce coke material from forming on the TLE tubesheet **6**. Generally, the amount of steam ranges from about 0.5% to about 10% of the flow of the hydrocarbon effluent **48**. Preferably, the amount of steam injected is in a range of about 1% to about 3% of the flow of the hydrocarbon effluent. The pressure of the steam injected into the hydrocarbon effluent **48** is in a range of about 30 psig to about 150 psig. Preferably, the pressure of the steam injected into the hydrocarbon effluent **48** is in a range of about 30 psig to about 50 psig.

Example

The following example is provided to assist a person skilled in the art with further illustrations of this invention. This example is intended to be illustrative of the invention but is not meant to be construed as limiting the reasonable scope of the invention.

Example #1

In a commercial test, an apparatus to inject steam to reduce coke material from forming on the TLE tubesheet of a hydrocarbon cracking furnace was tested. The steam was injected using six injection probes and a steam rate of about 0.5 to about 3% of the total flow of the hydrocarbon effluent flow rate. The pressure of the steam used was in a range of about 30 psig to about 60 psig, preferably in a range of about 50 psig. The injection probes on the TLE cone were located 14 inches from the TLE tubesheet. During the test, the pressure increase at the TLE tubesheet was measured. An increase in pressure of less than 5 psi was observed. Generally, during normal operation without steam injection, a pressure increase in a range of about 8 psi to about 17 psi due to coke material forming on the TLE tubesheet is observed. The TLE was able to operate up to 50% longer using the steam injection than under normal conditions without the steam injection.